AD-A055 112 NORTHWESTERN UNIV EVANSTON ILL DEPT OF PSYCHOLOGY F/G 5/10
FACTOR COMPOSITION AND ATTRIBUTE FUNCTIONING IN MEMORY.(U)
APR 78 B J UNDERWOOD N00014-76-C-0270
UNCLASSIFIED NL

1 OF 1
AD
A055112

END
DATE
FILMED
7-78
DDC

Final Report

FACTOR COMPOSITION AND ATTRIBUTE FUNCTIONING IN MEMORY

Benton J. Underwood

Northwestern University

April, 1978

Approved for public release; distribution unlimited.

Project RR 042-06
Sponsored by
Personnel & Training Research Programs
Psychological Sciences Division
Office of Naval Research
Arlington, Virginia
Contract No. N00014-76-C-0270

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)

E[redacted]

6 FACTOR COMPOSITION AND ATTRIBUTE FUNCTIONING IN MEMORY.

5. TYPE OF REPORT & PERIOD COVERED

9 Final Rep[redacted]t. 1 Sep 74-31 Dec 77,

[redacted]

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)

10 Benton J. Underwood

8. CONTRACT OR GRANT NUMBER(s)

15 N00014-76-C-0270

9. PERFORMING ORGANIZATION NAME AND ADDRESS

Northwestern University
Psychology Dept.
Evanston, IL 60201

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

61153N; RR042-06; RR042-0601; NR 154-371

11. CONTROLLING OFFICE NAME AND ADDRESS

Personnel and Training Research Programs
Office of Naval Research (Code 458)
Arlington, VA 22217

12. REPORT DATE

11 Apr[redacted]78

13. NUMBER OF PAGES

15

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)

16 RR04206

17 RR0420601

15. SECURITY CLASS. (of this report)

unclassified 12 14p.

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

DDC
JUN 12 1978
F

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

factor analysis
simultaneous learning
recognition
temporal coding

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The resport summarizes the work dealing with: (1) factor analyses of various learning tasks; (2) the phenomena which emerge when several verbal tasks are learned simultaneously; (3) temporal coding of memories; (4) spontaneous integration in recognition memory; (5) the effect of associative context on recognition; (6) the spacing effect in various types of learning tasks.

DD FORM 1473 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

402 739

Final Report

FACTOR COMPOSITION AND ATTRIBUTE FUNCTIONING IN MEMORY

Benton J. Underwood

Northwestern University

April, 1978

Project RR 042-06
Sponsored by
Personnel & Training Research Programs
Psychological Sciences Division
Office of Naval Research
Arlington, Virginia
Contract No. N00014-76-C-0270

The research followed three somewhat different channels: (1) attribute functioning in working memory; (2) factor composition of memory; (3) experimental analysis of attribute functioning. This report will be organized around the three channels.

Attribute Functioning in Working Memory

Reported Work

Two technical reports have described the research which was conducted in this channel. The major report, entitled "The Simultaneous Acquisition of Multiple Memories," was distributed in September, 1977. A summary of this report follows:

> The basic paradigm required the subjects to learn four verbal tasks simultaneously. Each task was given a separate retention test (recall, recognition, frequency judgments, serial ordering). The materials to be learned were presented on a series of slides at a 20-second rate. Each slide carried stimuli from more than one of the tasks. The purpose of the research was to determine (1) if the effects of certain intratask independent variables were the same as found when single tasks were learned; (2) the incidental learning which occurred when instructions specified the learning of less than the number of tasks presented; (3) the stability of the memories formed as determined by retention tests over a few minutes; (4) if differential encoding of the tasks occurred as a consequence of having different retention tests. The number of tasks specified to be learned differed, with four tasks always presented. In other conditions, the number of tasks presented varied as well as number specified for learning.
>
> The results showed that the effect of certain intratask independent variables was much the same as found when the tasks are learned singly. For example, the spacing effect occurred persistently under a wide variety of conditions, including incidental learning. There was no measurable forgetting over several minutes for any of the tasks despite the fact that the retention intervals were filled with other memory tests. Incidental learning occurred, but it was not great in an absolute sense. Evidence for differential encoding appeared but it was not a consequence of the simultaneous learning of tasks because the same evidence appeared when the tasks were learned separately. As might have been anticipated, the rate of acquisition of any one task decreased as the number of other tasks being learned increased.
>
> Manipulations of study time led to some puzzling findings. When a single task was presented, recall increased directly from 5 seconds of study time to 20 seconds of study time, but neither recognition nor frequency judgments was increased by study time beyond 5 seconds. Nevertheless, performance for the latter two tasks increased over trials. Furthermore, despite the fact that the performance did not increase as study time increased beyond 5

seconds, performance was better than when both tasks were learned simultaneously with a 20-second exposure period.

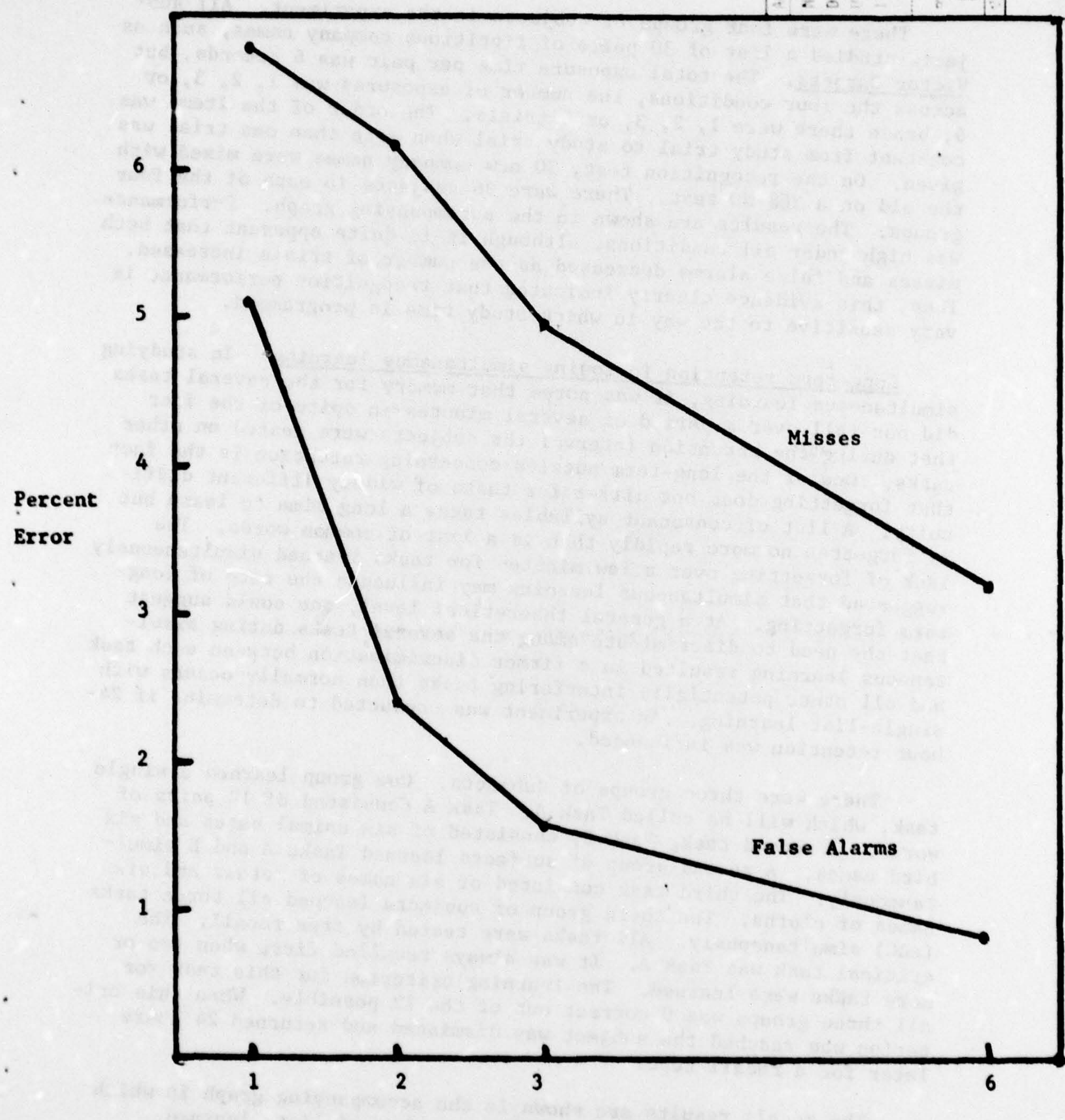
The second technical report was entitled "Recall and Recognition of Tasks Learned Simultaneously, and was distributed in July, 1977. A summary of this report follows:

Three clearly distinguishable lists were given simultaneously for learning. In one condition, subjects recalled all three lists; in a second condition, each list was given a different type of retention test although one of the lists was recalled. All subjects were fully informed of the materials and tests. The critical interest was in the recall of the same list in the two conditions. Several lines of thought led to the expectation that recall would be better when three different retention tests were used than when all lists were recalled. Three experiments gave little support to the expectation. To enhance differential encoding of the lists to match the retention tests, a fourth experiment was conducted that included a condition in which subjects learned each list separately before simultaneous learning. No evidence for differential encoding was found. There was relatively little transfer from single-list learning to simultaneous learning, suggesting that switching from a single list to simultaneous learning of three lists represents a marked change in context.

<u>New Work</u>

Two experiments were completed during the fall quarter which were suggested by the research on simultaneous learning. The procedure and the basic results for each of these will be described.

<u>Recognition as a function of number of trials with total time held constant</u>. As described in the first technical report listed above, it was shown that if items being studied for recognition testing were exposed for 5, 10, or 15 seconds, performance did not increase with exposure time beyond 5 seconds. However, if a second study trial was given, performance improved sharply. The puzzle is, perhaps, obvious. Given a 15-second exposure, why should a second study trial enhance performance when the subjects appeared not to have used 10 seconds of the study time on the *first trial*. The evidence suggests that a very important variable involved in recognition is the manner in which the total study time is divided. More specifically, it appeared that the greater the number of *presentations for study*, keeping total time constant, the better the recognition performance. In some of the research done under the present contract, recognition has been investigated under the assumption that frequency information is primarily involved in recognition decisions. If it is found that the number of trials (keeping total study time constant) directly determines recognition performance, the frequency theory would be supported.



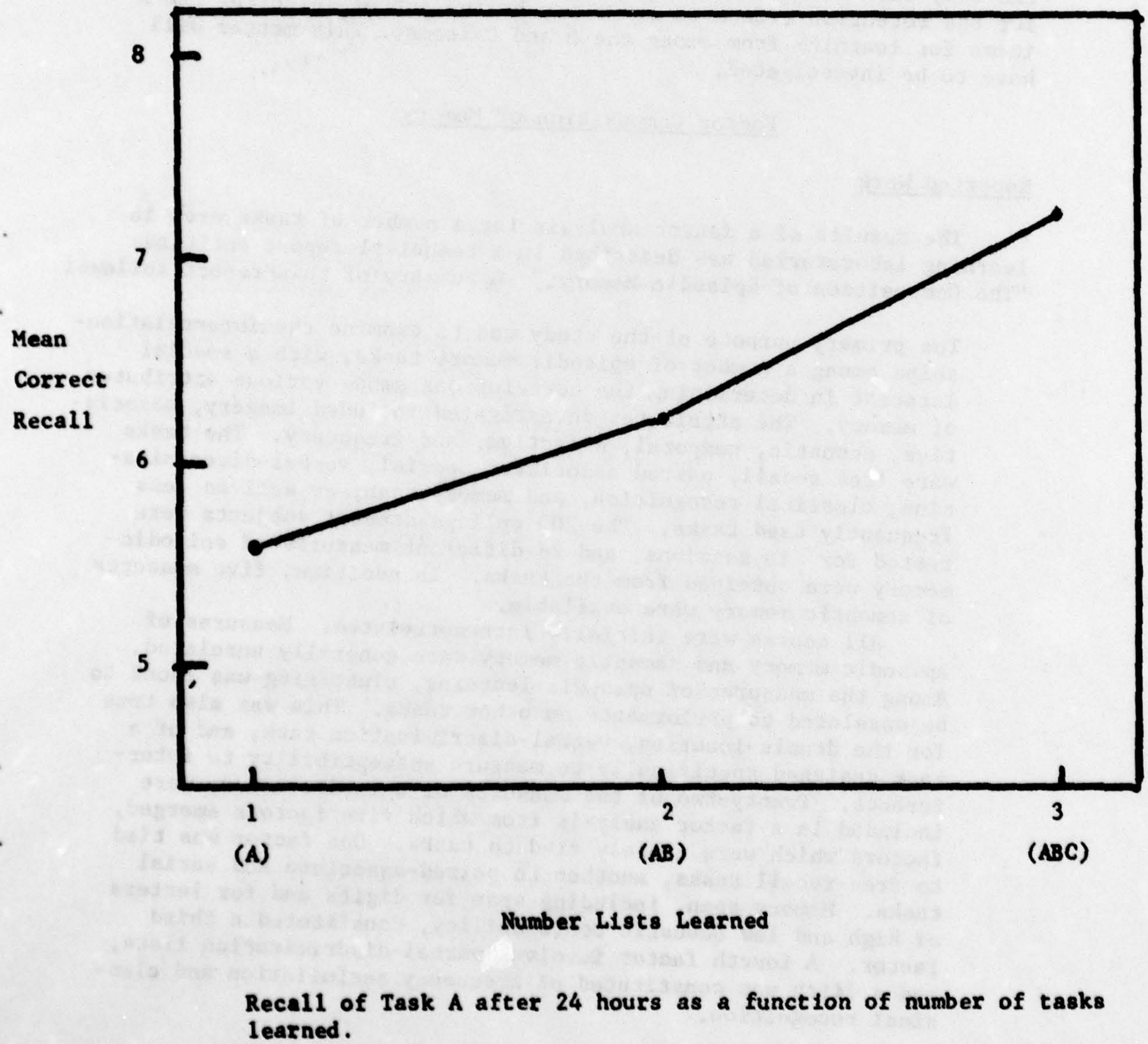
Effect of number of exposures of a list on recognition memory, holding total time constant.

There were four groups of subjects in the experiment. All subjects studied a list of 30 pairs of fictitious company names, such as Victor Carpets. The total exposure time per pair was 6 seconds, but across the four conditions, the number of exposures was 1, 2, 3, or 6, hence there were 1, 2, 3, or 6 trials. The order of the items was constant from study trial to study trial when more than one trial was given. On the recognition test, 30 new company names were mixed with the old on a YES-NO test. There were 36 subjects in each of the four groups. The results are shown in the accompanying graph. Performance was high under all conditions, although it is quite apparent that both misses and false alarms decreased as the number of trials increased. Thus, this evidence clearly indicates that recognition performance is very sensitive to the way in which study time is programmed.

Long-term retention following simultaneous learning. In studying simultaneous learning, it was noted that memory for the several tasks did not fall over a period of several minutes in spite of the fact that during the retention interval the subjects were tested on other tasks. One of the long-term puzzles concerning retention is the fact that forgetting does not differ for tasks of widely different difficulty. A list of consonant syllables takes a long time to learn but is forgotten no more rapidly than is a list of common words. The lack of forgetting over a few minutes for tasks learned simultaneously suggested that simultaneous learning may influence the rate of long-term forgetting. At a general theoretical level, one could suggest that the need to discriminate among the several tasks during simultaneous learning resulted in a firmer discrimination between each task and all other potentially interfering tasks than normally occurs with single-list learning. An experiment was conducted to determine if 24-hour retention was influenced.

There were three groups of subjects. One group learned a single task, which will be called Task A. Task A consisted of 12 pairs of words. A second task, Task B, consisted of six animal names and six bird names. A second group of subjects learned Tasks A and B simultaneously. The third task consisted of six names of metals and six names of cloths. The third group of subjects learned all three tasks (ABC) simultaneously. All tasks were tested by free recall. The critical task was Task A. It was always recalled first when two or more tasks were learned. The learning criterion for this task for all three groups was 9 correct out of the 12 possible. When this criterion was reached the subject was dismissed and returned 24 hours later for a recall test.

The recall results are shown in the accompanying graph in which recall is plotted as a function of the number of lists learned. Clearly, recall increased directly as the number of lists learned increased. Even with only 18 subjects in each group, the differences were highly reliable ($p < .01$). It might be argued that there was not



Recall of Task A after 24 hours as a function of number of tasks learned.

an appropriate control to conclude that simultaneous learning was responsible. The proper control, it could be argued, would be the recall of A after learning the tasks in sequence. However, if the tasks were learned in sequence, Tasks B and C essentially serve as interpolated tasks for A, and retroactive inhibition should occur. In effect, then, the results may be more impressive than appear at first glance; simultaneous learning has positive effects which more than compensate for any possible interference among tasks. As a second argument, it could be said that it has not been demonstrated that simultaneous learning is responsible. This is correct. It is possible that the same effect could have occurred even if Task A was the only task learned in conditions AB and ABC. The critical condition for the retention effect to occur may be the act of selecting the A items for learning from among the B and C items. This matter will have to be investigated.

Factor Composition of Memory

Reported Work

The results of a factor analysis for a number of tasks used in learning laboratories was described in a technical report entitled: "The Composition of Episodic Memory." A summary of this report follows:

> The primary purpose of the study was to examine the interrelationships among a number of episodic memory tasks, with a special interest in determining the correlations among various attributes of memory. The attributes investigated included imagery, associative, acoustic, temporal, affective, and frequency. The tasks were free recall, paired associates, serial, verbal-discrimination, classical recognition, and memory span, as well as less frequently used tasks. The 200 college-student subjects were tested for 10 sessions, and 28 different measures of episodic memory were obtained from the tasks. In addition, five measures of semantic memory were available.
>
> All scores were initially intercorrelated. Measures of episodic memory and semantic memory were generally unrelated. Among the measures of episodic learning, clustering was found to be unrelated to performance on other tasks. This was also true for the double-function, verbal-discrimination task, and of a task designed specifically to measure susceptibility to interference. Twenty-two of the measures of episodic memory were included in a factor analysis from which five factors emerged, factors which were closely tied to tasks. One factor was tied to free-recall tasks, another to paired-associate and serial tasks. Memory span, including span for digits and for letters of high and low acoustic confusability, constituted a third factor. A fourth factor involved verbal-discrimination lists, and a fifth was constituted of frequency assimilation and classical recognition.

The failure of attributes to form factors seems to have been due to two contrary forces. First, among tasks in which associative learning is required, the individual differences in associative learning are so strong that any additional variation which might be produced by attributes have little influence. The fundamental problem is to understand associative learning and the attribute conception has little to contribute to this issue. Second, there was some evidence that experienced subjects can set aside attributes when using them as a basis for responding produces interference. The presence of attributes in memory, and the utilization of attributes for responding, are two independent matters.

New Work

The above described analysis showed that free-recall tasks formed one factor and serial and paired-associate lists a second factor. All three tasks are generally assumed to involve associative learning. The question is then, why two factors? Why not just one factor? The possibility arises that there may be more than one kind of association, or to say this another way, there may be qualitative differences in associations. If this is true, it seemed possible that it might be detected by using transition tasks in which characteristics of both factors were represented. This was a major reason for undertaking a new factor analysis in which only associative tasks were represented. The major characteristics of the new study were as follows:

1. All lists of words were constituted by randomly drawing five-letter words. Thus, all tasks were made up of words of statistically equivalent features.

2. In order to make an extreme test of the role of meaningfulness on factor structure, three-word sentences (e.g., Plane flew low.) were used for some of the tasks (see below).

3. All tasks were given for two study-test trials, and there were two tasks of each kind.

4. Two temporal coding tasks were included in the battery but the outcome for these tasks did not help us in our attempt to understand how temporal discrimination are made.

5. There were 97 college-student subjects, each paid $15.

The tasks were as follows:

FR1. A standard free-recall task of 24 words.

FR3. A free-recall task in which the units were word triads. The subject was required to recall the three words in a triad together, but the order within the triad, and the order of the triads, was unspecified. There were 8 triads.

FRS. A free-recall task in which the units were 12 three-word sentences. The sentences could be recalled in any order.

SL1. A standard serial list of 24 words.

SL3. A serial list in which the units were 8 triads. The subjects had to recall the triads in the order presented for study, but the order within each triad was unspecified.

SLS. A serial list in which the units were 12 three-word sentences. The sentences had to be recalled in the order presented for study.

PA1. A standard paired-associate list of 24 pairs.

PA3. A paired-associate list (8 pairs) in which the response terms were word triads. A triad had to be associated with a particular stimulus term, but the order of the words within each triad was unspecified.

PAS. A paired-associate task (12 pairs) in which the response terms were three-word sentences.

PA2. A paired-associate task in which there were two different response terms to be associated with each stimulus term. There were 24 pairs, hence 12 different stimulus terms.

PA6. A paired-associate task of 24 pairs in which six different response terms were to be associated with each of the four stimulus terms.

PA12. A paired-associate task of 24 pairs in which 12 different responses were to be associated with each of the two stimulus terms.

The basic results are shown in the two accompanying tables. Two conclusions indicated by the data of the first table should be emphasized. First, the use of sentences had an appreciable effect on the learning. This can be seen by comparing FR3 with FRS, SL3 with SLS, and PA3 with PAS. Second, tasks were quite reliable, varying from a low of .56 for the standard serial task to high of .87 for the standard paired-associate task.

The second table shows the intercorrelations among the 12 tasks. Generally speaking, the intercorrelations are high, and they essentially predict the outcome of a factor analysis, namely, that a single factor will describe the data. None of the different methods for determining factor structure gave different conclusions. All described the data as being best accounted for by a single factor accounting for 65% of the variance.

Mean Correct Responses Across Two Trials for Both Tasks Combined, with Standard Deviations and Correlations (Reliabilities) Between the Two Tasks of Each Kind.

Task	Mean	Standard Deviation	Reliability
FR1	13.52	2.67	.75
FR3	4.52	1.24	.56
FRS	7.79	1.53	.65
SL1	9.40	3.30	.56
SL3	3.93	1.48	.75
SLS	7.17	2.08	.73
PA1	11.01	4.79	.87
PA3	2.88	1.67	.63
PAS	8.18	2.22	.79
PA-2	11.44	4.46	.86
PA-6	11.21	4.02	.78
PA-12	10.82	3.86	.73

Intercorrelations of the 12 Tasks

	FR1	FR3	FRS	SL1	SL3	SLS	PA1	PA3	PAS	PA-2	PA-6	PA-12
FR1	--	68	66	56	65	58	69	56	59	67	64	56
FR3		--	76	55	79	67	74	63	65	72	66	60
FRS			--	49	65	70	66	52	72	63	59	61
SL1				--	68	57	57	53	46	60	53	50
SL3					--	73	75	70	67	70	66	63
SLS						--	72	60	72	65	63	66
PA1							--	83	84	87	78	74
PA3								--	71	76	69	63
PAS									--	72	70	65
PA-2										--	87	78
PA-6											--	84

We do not know why the present study yielded a single factor, whereas the previous one gave two factors. The N in the previous study was 200, as compared with 97 in the present one. However, the table of intercorrelations for the present tasks gives no evidence that free-recall learning is "breaking away" from serial learning and paired-associate learning. And, despite the differences in rate of learning produced by the sentences and unrelated word triads, there is no hint that the processes underlying the learning differs.

Experimental Analysis of Attribute Functioning

Reported Work

The research in this channel has actually involved three different areas of investigation. The greatest amount of effort has been centered on studies of temporal coding. Two technical reports have been distributed. One was entitled "Temporal Codes for Memories: Issues and Problems," and carried an April, 1977, date. The summary is as follows:

> Little is known about the accuracy of temporal codes for memories, and still less about the nature of the codes. This report addresses the central question of the mechanisms by which order information is attached to memories. The results of sixteen experiments indicate the role of some independent variables on temporal coding in relatively short-term memory and in long-term memory. Several experiments, in which changes in proactive inhibition are used as an indix of temporal differentiation show that the nature of the words making up the lists is involved fundamentally in temporal coding. Other experiments demonstrate that in relatively short-term memory a subject cannot learn to improve his performance in estimating how far apart in time two events occurred. Still other experiments show that recency judgments for two events improve with practice, but the improvement is minimally influenced by the temporal separation of the events. The context in which memories are established is shown to influence temporal codes only if an ordering metric is a part of the context. Several theoretical propositions are advanced to account for the findings.

The second technical report gives the results of six experiments which represent attempts to clarify certain issues raised by the studies in the first report. The second report, dated July, 1977, is entitled "Studies on the Acquisition of Temporal Codes for Words Within a List." A summary is as follows:

> Several different issues in the temporal coding of words were subjected to experimental analysis. Two experiments evaluated three response measures (recency judgments, position judgments, lag judgments) used to index temporal coding. Lag judgments were found to be of little use; subjects could make valid position

and recency judgments without being able to make valid lag judgments. Practicing lag judgments produced heavy positive transfer to the other two measures. Experiment III showed that correct recency judgments were a direct linear function of rate of presentation through 3 seconds. Experiment IV demonstrated that recency learning and two-category classification learning were substantially correlated, but a direct test (Experiment V) indicated that the two-category classification task cannot serve as a paradigm for recency learning. Experiment V also showed that word frequency had no influence on either recency learning or two-category classification learning. Experiment VI suggested that a recency principle may govern knowledge of temporal order for very short intervals of time.

Two studies were completed dealing with recognition memory. Both of the technical reports carry a September, 1975, date. One of the reports was entitled "The Integration of Discrete Verbal Units in Recognition Memory." A summary of this study follows:

The two experiments examined factors underlying false alarms on recognition tests when the elements of the test items were presented alone for study at different points in time, and when the elements were parts of different two-element units during study. In the former case lag between presentation of the two elements was varied. In one experiment two independent words were presented for study with varying lags, with the test being for the two words as a pair. In the other, elements of compound words were presented separately with the test being on the compound word. The subjects had to decide whether the two words had or had not been presented together on the study trial. Lag was not found to be a relevant variable and this fact, plus the findings on a special test of temporal discrimination, led to the conclusion that temporal judgments were not involved in the false alarms observed. Because it seems unlikely that a meaning response, evoked on the study trial, was also evoked on the test trial, the false alarms observed were attributed to the visual-phonetic-articulatory responses of the elements which were evoked on both the study and test trials.

The second report was entitled "Recognition Memory for Pairs of Words as a Function of Associative Context." A summary of this report follows:

The purpose of the studies was to test a theory of associative context (defined as the association between two words in a pair) on recognition memory. The theory states that culturally associated words in a pair and non-associated words in a pair differ after a single study trial in terms of their frequency representation in memory. Two experiments were required to show that the use of mixed lists of associated and non-associated

pairs was not the appropriate way to study the effect of associative context on recognition memory. The third experiment provided no support for the theory. Recognition of associated and non-associated pairs did not differ appreciably. The loss in recognition performance for single words taken from study pairs was the same for associated and for non-associated pairs. Frequency judgments paralleled the results for recognition decisions in most aspects of the data. It was concluded that associative context, specified in terms of the strength of the association between two words in a pair, is not a critical factor in recognition performance.

Finally, one further technical report carried the title "The Spacing Effect: Additions to the Theoretical and Empirical Puzzles." This was a report of four experiments dealing with massed versus spaced practice, and was summarized as follows:

> Four studies examined the MP-DP effect (spacing effect) in four quite different situations: recognition of letters, verbal discrimination, short free recall lists, and recall of MP items presented twice with an intervening interval inserted to produce forgetting. MP-DP differences were found in all studies. Of particular interest were three interactions. Subjects with a low criterion of responding in the letter study lost the MP-DP effect over a 30-second delay, and subjects with a high criterion did not. A clear MP-DP effect, but no lag effect, was found only with unmixed verbal discrimination lists. In free recall a sharp lag effect was shown for words presented three times but not for words presented twice. A forgetting interval inserted between the two occurrences of an MP item did not appreciably aid its recall. The results were found to pose severe problems for current theoretical ideas about the spacing effect.

New Work

In the second technical report dealing with temporal codes, an experiment was described which indicated that a recency principle was valid. Immediately after a given event has occurred as the last event in a series, knowledge of the temporal position of the last event is nearly perfect, but a loss occurs rapidly over time. The study tested intervals up to 27 seconds and found that all of the loss which occurred fell within the first 6 seconds. In retrospect, it seemed to us that the rapid loss may have been due to the fact that subjects were always tested four times after each series of events (a serial list of 10 words), these tests being at 0, 6, 15, and 27 seconds. Perhaps the loss was due to the testing; that is, a test on other items may destroy the recency information for the last item.

We undertook a second experiment, the aim of which was to eliminate the influence of testing on the loss of recency information for the

last item in a list. This was accomplished by giving the subjects lots of noncritical lists and testing them for varying numbers of times after each list. Thus, the subjects learned to expect at least one test on a list but just when this test would come could not be predicted.

The results were much the same as for the first study. The recency gradient extends for a period of time not exceeding 15 seconds, leveling off at some point between 6 seconds and 15 seconds. Our general conclusion is that there is a recency principle by which the percept of the most recent unitary event carries information concerning the position of that event in the series. This information is lost quickly and after the loss the decisions about temporal position are based upon other types of information.

The second experiment dealt with a quite different problem. A number of studies have been done in which recency judgments were used to index temporal coding. In these studies, the subjects are shown a list of words for study and on the test trial pairs of words from the list are exhibited and the subject is asked to decide for each pair which word was most recent, i.e., which occurred latest in the list. It has been assumed that the number of correct decisions can be used to indicate the recency information in general which the subject has for the list. Over successive trials the number of correct decisions increases, and correspondingly it has been assumed that this indicates or indexes temporal coding in general.

It occurred to us that our inference about general temporal coding may be in error. It is possible, perhaps, for the subjects to learn the correct word (the most recent word) in each pair with the knowledge being entirely specific to each pair tested. It seemed necessary to do a simple experiment to determine which interpretation is correct.

The subjects in a basic control condition were given six study-test trials on a 36-word list, the test trials consisting of recency judgments on exactly the same pairs of words. This is the usual way of studying recency decisions. For another group, the subjects were given three trials under exactly the same conditions as given the control subjects. Then, on trials 4, 5, and 6, a completely new set of pairings was used for the recency judgments. If recency judgments are specific to pairings and do not indicate a general knowledge of temporal relationships, performance should fall badly on the fourth trial, and in the extreme case, approximate the level of performance shown on the first trial. If the knowledge is general, the control and switched subjects should not differ on trials 4, 5, and 6.

The results of this study are reasonably conclusive. Subjects on the fourth trial do statistically as well when switched as when not switched, although there is a small decrement which remains on trials five and six following the switch, and which is statistically reliable ($p < .05$) when summed across the three trials. It seems proper to conclude that recency judgments are primarily measuring generalized temporal information. The amount of the learning that is specific to the pairs is minimal.

Journal and Book Publications

The spacing effect: Additions to the theoretical and empirical puzzles. Memory and Cognition, 1976, 4, 391-400.

Integration of discrete verbal units in recognition memory. Journal of Experimental Psychology: Human Learning and Memory, 1976, 2, 293-300.

Recognition memory for pairs of words as a function of associative context. Journal of Experimental Psychology: Human Learning and Memory, 1976, 2, 404-412.

Temporal codes for memories: Issues and problems. Hillsdale, New Jersey: L. Erlbaum Associates, 1977.

A recognition test of vocabulary using signal-detection measures and some correlates of word and nonword recognition. Intelligence, 1977, 1, 5-31. (This work was done under an earlier contract.)

Individual differences as a crucible in theory construction. American Psychologist, 1975, 30, 128-134.

To Be Published

The technical report entitled "The Composition of Episodic Memory" will be published in the Journal of Experimental Psychology: General.

The technical report "The Simultaneous Acquisition of Multiple Memories" will be published as a chapter in a book in the series on Learning and Motivation, edited by G. Bower.

As noted above, a technical report was prepared entitled "Studies on the Acquisition of Temporal Codes for Words Within a List." The first two studies described in this technical report will be published in the Journal of Verbal Learning and Verbal Behavior. The fourth and fifth studies will be published in the Bulletin of the Psychonomic Society. The sixth study dealt with the recency principle and as described earlier, further work seemed necessary on this topic. The third experiment in the technical report probably will not be published.